

Gamification of Education: Cities Skylines as an educational tool for real estate and land use planning studies

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Abstract. *Computer games and other simulations have for a long time been used as a teaching method all around the world. They give a comprehensive, but simplified view of the reality to students with a hands-on approach to problems. Games as a teaching method offer competitiveness and a chance to see the results of decision-making in real time. These elements offer a different kind of inner motivation to learning, which usually is highly welcomed among students. Computer games give a contrast to the everyday not-so-interactive class teaching, and therefore have gained high popularity in schools and universities as a method for engagement.*

Cities Skylines is a city planning game that offers a simplified city planning experience, but also a surprisingly in-depth understanding of a city and its various functions. Alas, the planning system in the game is streamlined and does not include a realistic view of a city planning process with its multiple participants and developers. However, the city as a functioning system is well modeled and has some real potential for educational purposes. As a stand-alone game Cities Skylines does not fully meet the requirements for an educational game in the field of real estate or city planning. Nonetheless, the game is an exceptionally well developed platform and supports plethora of modifications. With a select few, well-thought modifications, the game would support educational uses, especially city planning problem solving using scenarios.

1 Introduction

1.1 Background

The purpose of this research is to map the most relevant issues that need to be considered for using the computer game – Cities: Skylines – as an educational tool at Aalto University.

Currently Aalto University department of real estate, planning and geoinformatics is using the game Urbax 3 for educational use in the course Game in Urban Planning and Development to teach students the practices of urban development process. This game is outdated, does not have any visual elements and is cumbersome for effective teaching. Therefore the university has started considering replacing Urbax 3 with an alternative. One of the games considered is a city planning game Cities Skylines. This research aims to take a closer look at the game and its strengths and weaknesses, in order to give recommendations regarding using the game in education.

1.2 Research questions

The aim of this research is to provide thorough insight into Cities Skylines so that an advised decision can be made on whether the game is suitable for educational use in the department of real estate, planning and geoinformatics.

The goal of this research is to find answerw to the following research questions:

- Does Cities Skylines have an in depth understanding of real land use planning mechanics and can the game be considered as a realistic simulation of city planning?
- Is Cities Skylines applicable for educational purposes as a stand-alone game?
- Is it possible to modify the game in order to fulfill educational goals?

1.3 Research methods and material

This research uses qualitative methods to answer the research questions. The research will consist of a literature review and an empirical part. The literature review will assess the tren of gamification, the qualities of games used in education, as well as the special requirements presented by the Finnish planning system. The literature review is based mainly on international literature and research done by different organizations, institutions, authorities and private persons. Also Finnish literary will be examined.

The empirical part consists of gaming sessions conducted by three researchers. Two of the researchers participate in the actual gaming experience and one acts as an observer. Additionally the game mechanics are analyzed through the use of an online information platform Skylines Wiki and this information is compared to the actual gaming experience.

The main intention is to analyze the empirical data and reflect the result with the theoretical background provided by the literature review. Finally there will be a conclusion on whether Cities Skylines is suitable for educational use in the field of real estate and land use planning.

1.4 Limitations of study

The literature review of this research will be limited to games in education as well as the requirements of a game that are presented by the city planning system in Finland. The empirical part is limited to a qualitative analysis of the gaming experience supported with the instructions of the game mechanics.

This research will be solely focused on whether Cities Skylines is suitable for educational use in the field of real estate and land use planning. The research will not take into account any comparison of different city planning games and their suitability to educational use. All the other games mentioned are compared as a part of the theoretical background and no empirical comparison will be made with these games. The main focus of the research is to provide an understanding of Cities Skylines and its properties from the perspective of educational use in university level. Other possible educational purposes will not be examined.

2 Gamification of Education – Literature Review

This chapter outlines what is gamification and highlights central findings from academic literature regarding gamification of education and main functions and features of modern Urban planning is discussed. Material that is used in chapter 2.1 is mainly Finnish literature

and relevant to Finland, but same features and challenges of urban planning are present in other countries as well.

2.1 Main functions and features of modern Urban Planning

In Finland, national land use guidelines are the basis for the local detailed plans. Planning system consists of four-level hierarchy and the main principle is that in the top of the system are national land use guidelines which steer the regional and local master plans. Municipalities draft and approve the local master and local detailed plans, which is the most detailed plan used. (Land use planning system, 2013.) In addition, in Finland special land-use contracts have speed up the development process and transferred costs to landowners. (Majamaa, 2008; Finnish Land Use and Building Act 132/1999.) In planning system cities or districts are considered to be more like components of the entity than individual and isolated elements. Cities are increasingly co-operating and for instance providing common services to one another which can be seen transactions between the municipalities (Leppisaari, 2011).

Though cities are considered to be working together and forming an entity, they are also competing of tax payers i.e. enterprises and inhabitants. The manner in which they do that can make the city more attractive for developers but also provide social infrastructure facilities and public services which need to be funded with tax revenues (Edelman 2007; Majamaa, 2008).

One of the elements steering the urban planning is legislation. Finnish Land Use and Building act (132/1999) describes the planning process in every planning level, interactions during the process and how the planning should be implemented taking every aspect, e.g. economical, sustainable and services, into account. The act allows all actors to participate the planning. Practically urban planning process can take several years with the current system where the end-users, mostly inhabitants, are not taken into account in the earliest stage (Majamaa, 2008). Inhabitants and their data (e.g. public services and public transportations) from every city part are explicitly considered to be the most crucial and relevant resources while implementing sustainable urban development (Horelli, 2013; Kyttä et al., 2008; Majamaa, 2008).

Urban development process is triggered by stakeholders or public authorities, all of whom are pursuing their financial, social and/or environmental interests. These parties are proactive and want make sure that planning will be implemented in a way that achieves their goals. (Edelman, 2007.) Though urban development should be steered by the public urban planning system, it is assumed that the main contributors are developers and construction companies which might not have knowledge of the local infrastructure functionality (Horelli, 2013).

2.2 Definition of gamification

If you have ever improved your profile strength on LinkedIn or received a “badge of trustworthiness” after car maintenance, you have been “gamified”, whether you realised it or not.

Gamification is a broad and rather recent term, and eludes a standard definition. In essence, it means utilisation of game mechanics and game thinking in order to engage users with various tasks that can range from education to business to ending poverty (McCormick, 2013). With regards to education, gamification can thus be defined as utilising games, or game-like elements such as score, challenge and achievement, in order to improve communication, learning and motivation (Deterding as cited in Banfield, 2014). Very simply

the idea is as follows: If people like to play games, as they are fun, catching and engaging, these elements should be integrated to education (McCormick, 2013).

2.3 Market for Gamification

Gamification is growing rapidly. The global market is estimated to grow from \$240 million to \$2,6 billion in 2016 according to M2 Research (as cited in McCormick, 2013), with some 70% of Forbes Global 2000 companies using at least one gamified application in 2014. However McCormick (2013) highlights that gamification also involves plenty of hype, and only a fraction of attempts will be successful at first. It is unclear what the market for gamified education is, as the line of traditional education and gamified education is not overly distinct.

Nevertheless, Gibson (et al., 2014) discusses that there is an increasing communication gap in education, as the so-called millennials used to digital world will find traditional classroom learning uninspiring and disengaging, and technology changes faster than methods of education.

2.4 Illustrative Cases

Here is a selection of cases to illustrate the power of gamification in educational or academic endeavours:

- Lockheed Martin, one of the leading defense contractors in the United States, thinks that games can be an efficient way to teach flying. They acquired the now-discontinued Microsoft Flight Simulator, and re-developed it into a serious educational tool called “Prepar3d”. Now they are licensing it for flight training as legitimate educational software. (Lockheed Martin, n.d.). It should be noted, that Lockheed Martin had to modify the original game in order to serve education purposes, and for instance remove unrealistic flight dynamics.



Figure 1. Lockheed Martin's “Prepar3d” flight simulator is an advanced example of gamification

- Washington University's Center for Game Science has successfully used gaming in complex AIDS research (Khatib et al., 2011). Their game Foldit invites gamers, most of who have no knowledge of biochemistry, online to solve complex protein-structure prediction problems. The goal is to achieve the lowest-energy proteins through online teamwork. Over 240,000 players were able to solve a long-standing protein crystal structure problem in just three weeks, which is a major step in curing retroviral diseases such as AIDS.

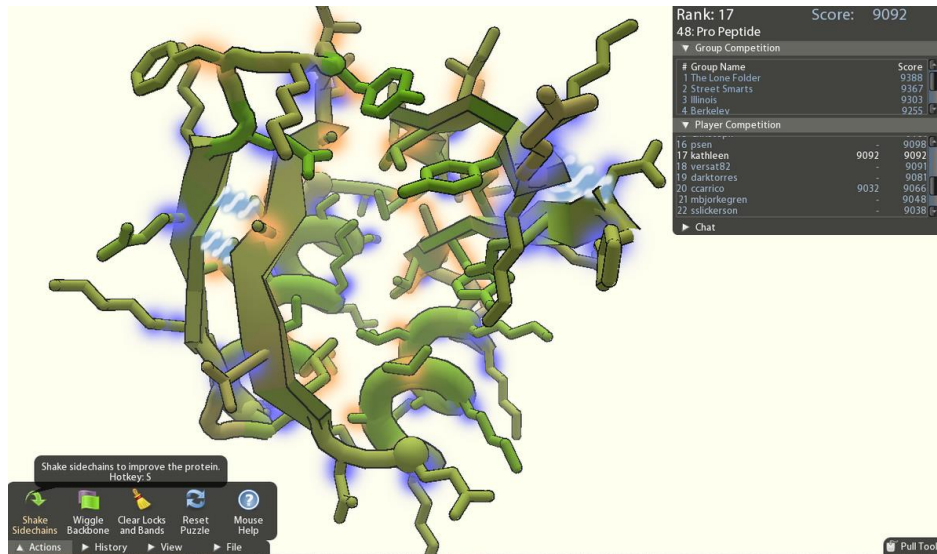


Figure 1. Washington University's "Foldit" for protein research.
<http://educade.org/system/pictures/attachments/51c2/17cc/b381/58eb/0200/0005/original/competition.png>

- Khan Academy, a leading online university, has incorporated various gamification aspects to their online teaching platform (Buenger, 2011). It visualises learning progress with skill trees, punishes for multiple wrong answers with a learning video and makes the learning process interactive and point-based step-by-step journey (Buenger, 2011). While Khan Academy may not be challenging traditional academic institutions anytime soon, the US Department of Education's \$3 million study (Schneider et al., 2014) into the Academy's effectiveness of mathematics teaching is telling of its influence.

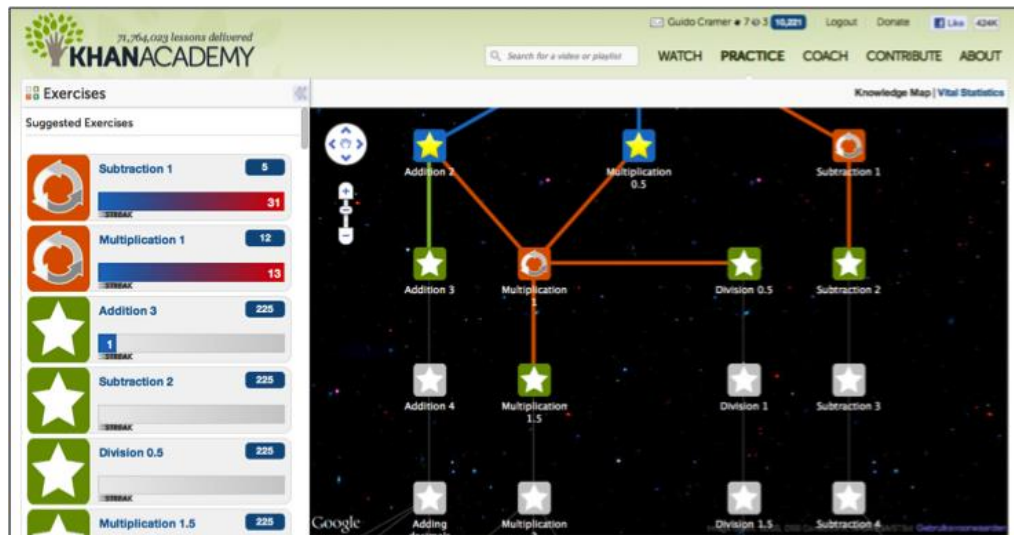


Figure 3. Khan Academy's gamification aspects. <http://www.fanminds.com/wp-content/uploads/2011/09/Khan-Academy-map1.png>

- Banfield (et al., 2014), studied gamification in educating system administration and information assurance in undergraduate courses. He found that at present there is very little human interaction in education classroom, which decreases motivation and self-efficacy. He notes that motivation in school is mostly extrinsic, meaning for instance focused on grade or simply completing a task, and that ideally motivation should be intrinsic, which would arise from pleasure, joy or satisfaction of completing a task (see figure 4). Games aim for this latter. Banfield et al. found that use of pedagogic methods involving game-like elements had dramatic effects on intrinsic motivation on all levels of curriculum.

Table 1. Lei (as cited in Banfield, 2014) highlights the importance of intrinsic motivation.

Table 1: Intrinsic Motivation

“Word tree” examples; Coded Comments	<u>Intrinsic</u> Themes Identified by Lei (2010)
“Fun”	Experience pleasure in what they are doing
Questions why a setting was made	Attends to instruction
“Tough, but cool”	Perseverance
“Another issue down”	Applies skills and knowledge to problem
Tried “X”	Show creativity in action
Why? What if?	Striver for true understanding
“High score!!”	Regular evaluation or monitoring of own progress
“This wasn’t covered in lecture”	Organize knowledge and relate it to existing knowledge
“How have people found 5 errors”	Regular evaluation or monitoring of own progress
“Now the lecture makes sense”	Organize knowledge and relate it to existing knowledge
“I found more then 5 errors”	Undertake more challenging aspects of a task
“Can we do more of this?”	Does not depend on tangible reward

Table 2: Extrinsic Motivation

“Word tree” examples; Coded Comments	<u>Extrinsic</u> Themes Identified by Lei (2010)
" I could not evaluate and find errors in a running system"	Low self-esteem
"I'd try it for Extra credit"	Receiving extremely rewards or reinforcements (e.g. extra credit or bonus points)
"Competition WOULD have been important piece"	Competition for tangible rewards (e.g. honors and awards)
"I'd do the work as a class"	Social reasons for learning
Stupid/dumb, when will I use this	Learning compliance
"Scoreboard WOULD have helped me"	Competition for tangible rewards (e.g. honors and awards)
"Would we have to find all 5 errors for credit?"	Least effort needed

3 Empirical Part: The Gaming Session

In this chapter the game Cities: Skylines (Paradox Interactive, 2015) and its features are presented. The game is analyzed from a pedagogical point of view. The aim of this chapter is to give a comprehensive analysis on whether the game is suitable for learning purposes in the light of the literature review presented earlier.

Cities: Skylines was released on 10th March 2015 by Paradox Interactive (Nyt, 2015). It is a city-building game and it states to be a modern take on the classic city builder” (Paradox Interactive, 2015). The game is a single-player game, where the player acts as a mayor (and single handedly as the city planning institution) of the city under development (Cities: Skylines Wiki, 2015).



Figure 4. Cities Skylines game interface.

<http://www.pelit.fi/2015/03/cities-skylines-myynt-varttimiljoonan/>

3.1 Gaming session

The gaming session was conducted by three players on two computers. One of the players had already 20 hours of playing experience, one had one hour and one of the players was new to the game. The two already-started games were played while at the same time notes and comments about the game were written down. The focus was on the processes, functions and tools of urban planning in the game.

The players were building the city, using different tools and testing the mechanisms of the game. The aim was to build the city and maximize the number of inhabitants. In addition it was also tested what would happen if some parts of the city were left without attention or adequate facilities. This was important in order to find out whether any consequences would occur.

Player has a certain amount of money in the beginning of the game. This money is used to develop the city and to pay for the public services. The money is mostly spent on public investments: services (for example police, fire department, and healthcare), roads, water pipes, power lines and so forth. Player receives money in from of taxes. The taxes are in form of business tax for industry and commercial zones and residential tax for housing. The tax income is most likely modeled as a fixed percentage of individual income as more wealthy households and businesses pay more taxes. The “wealth” of a household is measured in both education level and land value of the site. The game clearly states that educated residents pay more taxes (in result of high-level jobs) and also recycle better, cause less crime and so on. Considering this, the best way for the player to make money is to have as many residents and businesses as possible, while maintaining as high land values and education levels as possible.

The land has no city plan in the beginning of the game and the planning is mainly in form of zoning, which is pretty streamlined. In zoning mode, you can select parts of land to enable a certain function to be built on it. The only prerequisite for zoning is a road

connection, but without basic amenities (water, sewage, electricity) a building cannot function in the area. You as a city planner can only affect in the density (high rise/low rise) that can be used and the function (Housing, industrial, office, commercial) which is allowed. As stated, only prerequisite for zoning is a road connection and road network does not have to be planned in any strategic manner. A formal city plan is not required and it is not possible to create a comprehensive city plan.

The player is only responsible for zoning and public services, as all private construction is executed by simulated “developers”. After the player indicates the areas for certain purpose, the areas start to get build automatically if sufficient amenities (water, electricity) are available for the site. This real estate development cannot be done by the player and it is thoroughly simulated by the game AI. However the game AI does not seem to have any “real” developers and the construction seems to be affected by very simple rules. If there is demand for certain functions and there are free zoned areas for these functions, the first areas to be developed are the ones with best accessibility to services, amenities and other attractions such as parks and landmarks. The areas can have different uses: low density residential, high density residential, low density commercial, high density commercial, industrial or office. As the value of the land rises it becomes possible to build high-rise buildings. Land value can be increased by providing citizens all services including education, fire and police stations, medical and death care, public transportation, and leisure (Cities: Skylines Wiki, 2015).

In order to change the land use the player can “de-zone” the areas which results in the demolition of all the activities and buildings in the area. After that new construction will begin automatically, if there is demand and the area is more attractive than alternatives. The expenses from de-zoning are (which results in demolition of all the buildings) is relatively low. The player is not required to take into account other opinions than that of his/her own. This de-zoning practice could be compared to situation where the city would use a compulsory purchase in all of the de-zoned areas and then demolish and re-zone the area completely. It should be quite clear at this point that such a practice would be politically impossible in real life and if conducted, very expensive for the city.

As mentioned before, the city planning in Cities: Skylines is mainly a one person “tyranny”, where all the decisions are made by the player and there is no real negotiation with other stakeholders. Also the game mechanics completely lacks some important aspects such as land ownership, which gives the player unrealistically easy control of ongoing development and redevelopment.

One curious part of a legislative system in the game comes in form of districts. Player can create districts by painting a certain area which can then be governed by varying policies. The policy options are given in the game and player can choose which ones to implement in a specific district. Each policy has certain consequences, for example banning heavy traffic makes an area less congested but makes it impossible for industrial businesses to survive in the area. There are also some policies that directly affect the happiness of the citizens, for example banning of pets would reduce garbage but also reduce happiness. Player can also impose tax raises or tax reliefs on different functions in a district. There are also some forms of subsidies and industry specialization mechanics imposed in the district tool but these are mainly ways to make gaming more interesting and have little to do with real city planning.

There are no active interest groups in the game other than the player. This means that the player’s role is significant and no other parties are involved in developing the city in any way. The main interest groups are passive and represented by a “Happiness” meter, which indicates the satisfaction of certain interest groups. These interest groups are for example residents, industrialists, commercial businesses and offices. Happiness is a very important

component in the game as it dictates whether or not there will be demand from citizens or businesses to move into the city. If the happiness level drops significantly it may even because a decline in population, but the game difficulty is set low enough that this is a very rare occurrence. Although the player's actions affect the overall happiness level, it is mainly controlled by long-term development such as service accessibility, employment, education and so on. The Mayor receives feedback from citizens in some form of social media (a variation of Twitter), but the only real way for a citizen or business to affect development is to boycott the city by moving out and forcing the player to make better decisions.

4 Discussion

Gamification as a phenomenon is influential and growing rapidly. It is also so varied that it is sometimes hard to spot just what is gamification. Muntean (as cited in Banfield et al., 2014) concludes that options for gamification in education are only limited by instructor creativity and have proven potential in more efficient and engaged learning behavior.

It is notable that the vast options and scene of gamification is also a challenge. Gamification is not a clear-cut solution, and will require different approaches depending on setting. For instance simulation works for flight training and skill-trees work for visualizing learning progress, but there are no universal guidelines yet for which gamification methods to use and how. Instructor creativity and sensible deployment seem to hold significant meaning to the success of gamification. The same is true for urban planning.

However, it is clear that positive results can be achieved, and thus games should be explored as potential tools for education (and other pursuits). A key benefit is the potential to increase intrinsic motivation in education. As suggested by findings in literature and empirical testing, it is likely that games will require modifications, unless initially developed for education, in order to be educational, which was the case with Lockheed Martin and some other examples. This is to emphasize the progress of learning and focus on theory, not only fun.

Cities and developers might be the most influential actors but to make sure that the process is carried out in reasonable time, it is necessary to involve citizens and other stakeholders as well. Municipalities may have the quantitative data of its areas but the citizens are holding the qualitative information which should be considered at least as valuable as the numbers.

It seems that competition between municipalities has affected the urban planning. As cities are gathering tax payers it can lead to implementing a planning that is not sustainable and not taking inhabitants into account. While cities are vying, they can, at the same time, be struggling economically. Low taxes among the economically weak cities can result in a debt spiral and impairing municipalities' (and thus inhabitants') position to partake in proactive urban planning.

4.1 Analysis and educational possibilities

Cities: Skylines is an interesting example that has many well thought ideas on city planning. The game comes up with a feeling of a real functioning city with many different aspects well simulated. However the game has some serious drawbacks when compared to city planning in real world. The most important of these drawbacks is the complete lack of land ownership especially in the redevelopment of existing areas. This flaw makes the game significantly less applicable for many education purposes. However, as noted, it could be possible to make a modification to the game which improves the land ownership simulation. The game

developers support modifying without reservations and the modifications can be freely shared within the gaming community, Steam. The already existing modifications vary from analysis tools to new buildings and everything in between. It seems feasible to develop a land usage modification for the game, and the original developers might well cooperate with the endeavours.

One of the most intriguing aspects of the game is the agent-based simulation of citizens in the city. The citizens actually go from home to work and to recreation and shopping and use different methods of transportation. The game does a good job in simulating the traffic and transportation system of a city and this makes it possible to simulate accessibility efficiently. Also the land value system in the city looks rather realistic although the mechanics are pretty straight forward. The land value raises mainly due to public services, shopping possibilities and the proximity of parks and recreational area, but for example an ocean view seems to have no effect. Also the high demand and low supply of for example residential does not raise land value and it has no effect in the house prices. The houses seem to have no price at all, but are upgraded into higher level housing as the land price rises.

Although Cities: Skylines has some pretty sophisticated game mechanics it still is a mainstream game that does not fully represent the problem solving of real life city planning. However with sufficient modifications for land value, redevelopment, real estate markets and the introduction of a land ownership system the game could be a very effective and interesting educational tool for city planning problematics. The educational uses could consist of different scenarios which could be made as previously developed save games and controlled with some thoughtful modifications. The scenarios could have a very strictly controlled economy and budget and some problematic scenarios, for example a bad traffic situation, along with noise pollution and degrading land value. In this scenario the player could be forced to make decisions to help revitalize the city center. One solution could be to develop a new residential area next to an existing office zone for reduced commuting and ban heavy traffic from the center while creating some new bus lines to reduce traffic jams and noise pollution, which in turn raise happiness and land value in the area. The positive cycle could result in increase of population and tax income. The most important aspect in educational use would be the budget control and the control of the cost mechanics of different methods of development.

4.2 SWOT-analysis

The before mentioned strengths and weaknesses of the game are summarised in a SWOT-analysis table with possible opportunities and shortcomings in the educational use of Cities Skylines.

<p style="text-align: center;">STRENGTHS</p> <ul style="list-style-type: none"> - Transportation and traffic system - Agent based citizen modeling - Public services and service accessibility 	<p style="text-align: center;">WEAKNESSES</p> <ul style="list-style-type: none"> - Lack of land ownership - Ridiculously easy redevelopment with no development cost for land readjustment - Very simplified land value system
<p style="text-align: center;">OPPORTUNITIES</p> <ul style="list-style-type: none"> - Engaging and motivating way to teach urban planning problem-solving - Simulation of traffic issues caused by land use decisions and development - Public service budgeting and placement 	<p style="text-align: center;">THREATS</p> <ul style="list-style-type: none"> - Resources wasted in modification development - modifications are unable to simulate real multi-participatory environment - Incorrect understanding of real life urban planning due to simplified game mechanics

Summary

Computer games and other simulations have for a long time been used as a teaching method all around the world. They give a comprehensive, but simplified view of the reality to students with a hands-on approach to problems. Games as a teaching method offer competitiveness and a chance to see the results of decisions in real time. These elements offer intrinsic motivation to learning, which is a superior way to engage students when compared to traditional classroom education with mostly extrinsic motivational aspects. Computer games give a contrast to the everyday not-so-interactive class teaching, and therefore have gained high popularity in schools and universities around the world.

Gamification has become hugely popular due to its potential, but it is not a clear-cut solution. This is also true with Cities: Skylines: the planning system in the game is streamlined and does not include a realistic view of a city planning process with multiple participants and developers. However the city as a functioning system is very well modeled and has some real potential for educational purposes. Luckily the developers of the game support modifications. A modification including complementing features – land value, redevelopment, real estate markets - can be implemented and consequently we believe Cities: Skylines could be used for educational purposes.

As a stand-alone game Cities Skylines does not fully meet the requirements for an educational game in the field of real estate or city planning due to the lack of important city planning aspects such as land ownership. However the game is exceptionally well developed to support necessary modifications to tackle the issue, which means many problems can be overcome and the game customised to educational settings. We would recommend Cities Skylines to educational purposes due to its excellent overall modelling of the city as a system.

However due to some major shortcomings the recommendation stands only if there is motivation and resources for developing and implementing modifications for the game.

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